# <u>ECOPOIESIS: SHOULD WE IMPLANT LIFE ON MARS?</u>

The Earth is perceived to be in crisis largely because of human population growth coupled with increasing economic expectations and our traditionally shabby management of wastes and resources. Unfortunately, it is hard to predict the consequences of large scale environmental perturbations insofar as the 'physiology' of the biosphere and the climatology of Earth remain poorly understood. A surprisingly informative approach to the discovery of fundamental gaps in our knowledge of global ecology is to ask how one might generate a biosphere on Mars. There are many arguments both for and against the actual implantation of life elsewhere in the solar system. However, in this essay we outline only the relevance of this question to the science of global change and the unique ethical issues that it raises.

<u>Ecopoiesis</u> is our neologism. Its Greek roots mean 'the making of home', a new abode for life. It denotes the fabrication of a self-sustaining ecosystem on a lifeless planet. This would create a new arena in which evolution could proceed, perhaps independently of further human intervention. The word <u>terraformation</u>, is used more specifically to describe the conversion of an alien planetary environment into one suitable for normal human habitation. The idea of propagating life on other planets is no longer confined to science fiction. Indeed, a small group of scientists met in 1988 at the NASA Ames Research

Center to assess the merits of ecopoiesis as a long range international objective for space exploration.

Missions to Mars have revealed that its surface is cold (temperate latitudes in summer average -60°C), dry, and almost certainly lifeless. Other than Earth, it is the least hostile planet in the solar system, even though any unprotected organisms which might arrive there would be freeze-dried, oxidized, and soon reduced to dust. Substantial quantities of water (in the form of permafrost) and other basic materials essential for the development of biogeochemical cycles, may exist in its crust. It has a thin (~8 millibars), mostly carbon dioxide, atmosphere. Its orbit, gravity, likely volatile inventory and other unalterable planetary parameters are such as could support, in principle, a much thicker $CO_2$ (~2 bars) atmosphere whose climate might be suitable for some anaerobic microorganisms.

Ecopoiesis would proceed through two main phases: First, planetary engineering to warm the climate sufficiently to allow the presence of liquid water and increase the thickness of its atmosphere by the release of frozen gases. Second, biological engineering to create communities of microorganisms selected (or genetically engineered) for growth in the newly 'salubrious' Martian environment. Rough calculations based on estimates of gross energy requirements of the first phase indicate that a microbial ecosystem could be implanted in about 200 years.

It is likely that Mars once possessed a much thicker carbon dioxide atmosphere and abundant surface water. Biological evolution might have started during this period, signs of which may be discovered during future missions to the planet. If such evidence comes to light ecopoiesis would constitute the restoration of a past habitable state rather than the creation of a new one.

The feasibility of ecopoiesis cannot be assessed on the basis of current knowledge. For example, Mars might not have enough accessible nitrogen to support a reasonably productive biosphere, and the amount of phosphorus has not yet been determined. Thus, we do not know whether ecopoiesis is possible or its success probable. Answers to these questions must await future Mars missions and further research on the structure and dynamics of Earth's biosphere.

A feasibility study of ecopoiesis would require detailed investigations of the climatology of Earth and Mars, of the past and present ecologies of Earth, and of technologies for planetary engineering. Earthbound research would have to include studies of the 'greenhouse effects' of carbon dioxide and other gases; the interrelations of biogeochemical cycles and their relation to geological activity; the factors that promote stability in ecosystems; the biology of the colonization and ecological succession of pioneering species on new land areas; and the mechanisms of biochemical adaption with particular emphasis on exotic organisms living in extreme environments. Planetary engineering would focus on the development of techniques for warming the Martian atmosphere and surface. This might be achieved by reducing the reflectivity of the polar ice caps coupled with the injection of trace amounts of 'greenhouse gases' into the atmosphere. The scope of this research would promise a rich scientific harvest, much of which would be relevant to environmental concerns on Earth even if ecopoiesis were found ultimately to be impossible or impracticable.

Ecopoiesis raises some novel ethical issues even if put forward merely as a theoretical exercise in planetary and ecological engineering. Traditional ethical discourse and theories of value are based on two ingrained habits of human thought: anthropocentrism and geocentrism. Thus, principles of ethics have been formulated primarily to guide and govern the relations among people here on Earth. However, the scope of ethical theory has been expanded recently to encompass all forms of nonhuman life, ecosystems, and even inanimate structures, such as rocks, landforms and barren planets. This radical environmental ethic includes the idea that Earth's rich and diverse biota is inherently good. Thus, the biosphere as (we think) we know it, <u>is</u> by definition what these theories assert <u>ought</u> to be. This conclusion clearly violates Hume's law: 'no <u>ought</u> deducible from <u>is</u>'. However, this logical gaffe is easy to overlook in light of the serious problems of environmental degradation we must solve. In such circumstances, what is (or perhaps was, a few generations ago) accords well with popular notions of what ought to be.

Ecopoiesis presents us with a choice between a dead and a living planet: what would be the greater good, Mars barren or Mars endowed with life? It is illogical to argue that a dead planet <u>ought</u> to remain as it is, simply because that is the way it <u>is</u>. On the other hand, arguments in favor of ecopoiesis conflict with latter-day claims of environmental ethics regarding the 'moral standing' of planets. If a viable ecosystem can be established on Mars, another question arises: Does this now 'indigenous' biota have a right to its own natural, but unpredictable, evolutionary trajectory, as currently exists for organisms on Earth? Or should the Martian biosphere be tended to ensure at least its early development in a manner agreeable to *Homo sapiens*? Clearly, ecopoiesis raises new philosophical questions for which answers may be found only through the adoption of a 'cosmocentric' theory of intrinsic values.

Suppose that a feasibility study does indicate that ecopoiesis is achievable. Suppose further that a living planet is viewed generally as having greater 'cosmic' value than a dead one. Why then would humans decide to undertake such an historic task, inasmuch as scientific feasibility and moral acceptability do not entail any obligation to proceed? Possible motives range from the sublime to the mundane. Perhaps the deepest reason would be the consistency of this project with the Promethean myths of many human cultures and the reproductive and proliferative imperatives that characterize life itself. The complementary challenges to preserve, and perhaps to propagate, life in the solar system bode well to sustain and inspire the 'global villagers' of the 21st century.

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